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# DEVELOPMENT OF ASSESSMENT FOR LEARNING-ORIENTED ELECTRONIC STUDENT WORKSHEETS TO IMPROVE STUDENT LEARNING OUTCOMES ON ACID-BASE TITRATION MATERIAL

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**Abstract:** This study aims to describe the feasibility of an Electronic Student Worksheet-oriented assessment for learning to improve the learning outcomes of class XI students of SMAN 1 Menganti Gresik, Indonesia, on acid-base titration material. The feasibility of the Electronic Student Worksheet developed is reviewed based on three aspects: validity, practicality, and effectiveness. This study used a Research and Development (R&D) method development design that refers to the Borg and Gall research and development model. This research was limited to the limited trial stage. The little trial was conducted on 18 SMAN 1 Menganti Gresik students who had received acid-base titration material. The feasibility of the Electronic Student Worksheet was reviewed from the validity aspect obtained based on the assessment results by the validator, which consisted of two chemistry lecturers from FMIPA Surabaya State University and one chemistry teacher from SMAN 1 Menganti Gresik. Validation by experts related to content validity and construct validity obtained a mode of 5 with a highly valid category. Practicality in students' responses by getting a positive reaction of 97.22% with a very practical category and observation of students' activities as supporting data which obtained more excellent students' relevant activities with an average percentage at the first meeting and the second meeting of 95%. Effectiveness in terms of the results of students' cognitive learning tests which have increased with the percentage of students who get N-gain in high criteria by 11%, while the percentage of students who get N-gain in medium criteria is 83%, and the percentage of students who get N-gain in low criteria is 6%. In the second meeting, the rate of students who got N-gain in high criteria increased by 89%, while the percentage of students who got N-gain in moderate criteria was 11%.

**Keywords:** *Electronic Student Worksheet, Assessment for Learning, Learning Outcomes, Acid-Base Titration*

## INTRODUCTION

Education creates an environment and learning process that allows students to actively develop their potential, including mental strength, self-discipline, individuality, intelligence, character, and skills needed for themselves, society, state, and nation [1]. Educational goals can be categorized into three main domains, namely the cognitive domain, affective domain, and psychomotor domain. Indonesia has now introduced the learning independence curriculum. It is an improvement from the previous curriculum to enhance learning, regulated in Permendikbudristek No.2 Number 56 of 2022 [2]. Learning outcomes are an indicator of the expected success of education.

The development of learning outcomes has a vital role in the learning process. Learning outcomes can be used as indicators to measure students' suitability level based on evaluations conducted through tests [3]. Substantially, learning outcomes involve changes in behavior that cover various aspects [1].

Chemistry is a science group subject at the Senior High School/Madrasah Aliyah level, included in the independent learning curriculum. One of the learning outcomes of chemistry is using acid-base concepts in everyday life, including acid-base titration material [4]. An acid-base titration is also taught to grade XI high school students every semester. The material about acid-base titration is abstract and complex for most students [5]. This material is considered difficult by students, especially in determining the concentration of two-valence acids, the concentration of monovalent acids, and the type of titration based on the acid-base titration curve [5].

Based on the results of preliminary studies at SMA Negeri 1 Menganti Gresik, out of a total of 36 students, 55.56% considered acid-base titration material quite complex, 30.56% difficult, and 5.56% found it very difficult. The remaining 8.33% of students do not think acid-base titration material is involved. The results of the preliminary study also showed that 72.2% of 36 students who studied chemistry did not use a particular learning method. It is closely related to the learning methods used in the learning process. Poorly structured learning methods can lead to unachievable results. Therefore, it is necessary to teach the correct learning methods to students that are planned and easy to implement [6]. Educators' assessment approach helps students find the right way of learning for them. Therefore, it is necessary to have an assessment approach that helps motivate students to learn. In general, the assessment approach educators use is limited to summative assessment [7] and focuses only on the end-of-learning test. Based on the above, there needs to be a learning

demand emphasizing post-learning feedback, namely review for learning evaluation.

Assessment for learning involves collecting and interpreting evidence about students' learning outcomes to assess the level of students' learning outcomes and identify areas where further support is needed and most appropriate. It is an ongoing evaluation process to help them succeed [8]. The quality of learning assessment used by educators can significantly impact the process and achievement of student learning outcomes. Students' performance and learning progress is revealed through assessment for learning, where students' performance on various tasks is assessed over a semester [9]. Feedback implementing afl is vital for educators to provide feedback on every task students do [10]. The aim is to improve students' learning outcomes and monitor the achievement of learning objectives by providing regular feedback.

In the 21st century, ensuring students are motivated to learn and innovate using information technology and media in the educational environment [11]. It is due to the ease of information dissemination, access, and vast communication opportunities. Therefore, the use of technology is crucial in this modern era to meet the needs of students during the learning process. For example, using Electronic Student Worksheets as a learning resource [11].

Electronic Student Worksheets is a student work guide written in electronic format to facilitate understanding of learning materials [12]. This guide can be accessed from computers, notebooks, and smartphones. Electronic Student Worksheets are created using the Zine web application. Heyzine is a web-based application that makes flipbook media in HTML format that can be accessed from various devices such as Android, iPhone, tablet, and PC [13].

According to research by [14], Student Worksheets not only function as a task that students must complete but also as a learning approach that helps understand concepts. Therefore, Electronic Student Worksheets can be combined with the assessment for the learning approach. Adopting this approach allows Electronic Student Worksheets to influence the assessment system used during the learning process. Some studies show that learning based on the assessment for learning approach can improve learning effectiveness. For example, [15] showed that applying afl assessment-based learning can improve students' learning outcomes on chemical equilibrium materials. Another study by [16] also found that assessment for learning-based learning effectively enhances students' learning outcomes, especially for reaction rate materials.

Based on the results of the analysis above, in improving the quality of learning, especially in the field of chemistry, the researchers are interested in conducting research with the title "Development of Assessment for Learning-Oriented Electronic Student Worksheets to Improve Student Learning Outcomes on Acid-Base Titration Material."

## RESEARCH METHODS

This study uses the R&D research and development method, which refers to the Borg and Gall research and development model. The Research and Development (R&D) method produces certain products and tests their validity, practicality, and effectiveness [17]. This research was only limited to product trials. The study was conducted in May 2023 within two weeks, with the research subjects being students in class XI-2 in the 2022/2023 school year. The data collection techniques used were questionnaires, observation, and test methods. Data results were obtained from the effects of validity, practicality, and effectiveness in the form of quantitative data.

Validation of the Electronic Student Worksheet includes content and construct validity conducted by three validators with quantitative descriptive method. Validators will provide an assessment score of 1-5 on the validation sheet. The data obtained is then converted based on the Likert scale in the following table:

Table 1. Electronic Student Worksheets Validity Assessment Score

| Score | Criteria |
|---|---|
| 5 | Highly Valid |
| 4 | Valid |
| 3 | Moderately Valid |
| 2 | Less Valid |
| 1 | Invalid |

[18]

The assessment of each aspect by the validator is declared valid or highly valid if it has a mode score $\geq 4$. If there are aspects that do not meet the valid requirements, it is necessary to make improvements (revisions) and revalidation until they reach the specified criteria [19].

Practicality is also measured in addition to measuring validity [20]. The practicality of the Electronic Student Worksheet can be known from the results of the students' response questionnaire and observation of students' activities as supporting data. Data on the results of the learner response questionnaire is obtained based on calculations using the Guttman scale score in the following table:

Table 2. Scoring of Response Questionnaire

| Answers | The score of positive statements | The score of negative statements |
|---|---|---|
| Yes | 1 | 0 |
| No | 0 | 1 |

[21]

The data obtained was calculated using the formula below:

$$\% \text{ practically} = \frac{\Sigma \text{ score obtained}}{\Sigma \text{ maximum score}} \times 100\%$$

The percentage of the results of the student response questionnaire is then interpreted according to the categories listed in the following table:

Table 3. Score Interpretation Categories

| Percentage (%) | Category |
|---|---|
| 0-20 | Impractical |
| 21-40 | Less Practical |
| 41-60 | Quite Practical |
| 61-80 | Practical |
| 81-100 | Highly Practical |

[18]

The Electronic Student Worksheets are said to be practical if the results of the student response questionnaire get a percentage ≥ 61% in the practical or very practical category [21].

Analysis of student activity observation data during the learning process was obtained using the student activity sheet. The data was analyzed using the following formula:

$$\% \text{ student activity} = \frac{\sum \text{frequency of student activities that appear}}{\sum \text{ frequency of overall student activity}} \times 100\%$$

Students' activities are declared to be well implemented and support the practicality of the application of the developed Electronic Student Worksheets if the percentage of relevant student activities is more excellent than irrelevant student activities by ≥85%.

Feasibility is also measured by effectiveness. The effectiveness of Electronic Student Worksheets can be seen from the improvement of each student's pretest and posttest results. The pretest and posttest score data obtained by each student is then analyzed to determine the value using the following equation:

$$\text{value} = \frac{\sum \text{score obtained}}{\sum \text{ maximum score}} \times 100$$

Learning outcomes can be assessed using a discrete assessment with a scale of 0-100. Students are said to be complete if they have reached the KKM (Minimum Completeness Criteria) value set by the school, which is ≥ 75.

The improvement in learning outcomes after applying the assessment for learning-oriented Electronic Student Worksheets was analyzed with the N-gain test to determine the difference in scores between the pretest and posttest after using the Electronic Student Worksheet developed with the following equation:

$$< g > = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

The calculation results obtained are then converted according to the gain score level criteria in the following table:

Table 4. Gain Score Criteria

| Score | Criteria |
|---|---|
| $<g> > 0.70$ | High |
| $0.30 \leq <g> \leq 0.70$ | Medium |
| $<g> < 0.30$ | Low |

[22]

Electronic Student Worksheet is effective if the total percentage of students in the high and medium categories is ≥85%.

## RESULTS AND DISCUSSION

The results showed that the learning-oriented Electronic Student Worksheet assessment on acid-base titration material could improve the learning outcomes of class XI SMAN 1 Menganti Gresik students. The results of the study include validity, practicality, and effectiveness.

### Validity

Validity was carried out through the validation stage by two chemistry lecturers FMIPA Unesa and one chemistry teacher, SMAN 1 Menganti Gresik. Validators assessed the feasibility based on content and construct validity by filling out the provided validation sheet. The criteria of content validity are; (1) suitability of learning objectives with learning outcomes, (2) suitability of chemical materials in Electronic Student Worksheet with learning objectives, (3) suitability of Electronic Student Worksheet with assessment for learning approach, and (4) correctness of the substance of learning materials.

The construct validity eligibility criteria include three parts, namely; (1) graphic, presentation, and linguistic criteria. (2) graphic criteria include harmony between text color, background, images, and tables. (3) presentation criteria include a cover that presents the contents of the Electronic Student Worksheets, a place to write answers as needed, and consistency of the presentation system. (4) linguistic criteria include the clarity of the information presented and conformity with good and correct Indonesian writing rules. The following are the validation results obtained after being filled in using the validation instrument.

From the data recapitulation table of validation results, the results of the feasibility of Electronic Student Worksheets content with a mode of 5 in the category of highly valid. Based on this, it shows that the content contained in the Electronic Student Worksheets follows the learning objectives and outcomes. Besides, the content in the Electronic Student Worksheets also follows the assessment for the

learning approach, and the truth of the substance of the learning material is also appropriate.

Table 5. Results of Validation of Electronic Student Worksheet

| No | Aspect | Mode |
|---|---|---|
| Content Feasibility (Content Validity of Electronic Student Worksheets) | | |
| 1 | Suitability of learning objectives with learning outcomes | 5 |
| 2 | The suitability of the chemistry material in the Electronic Student Worksheet with the learning objectives | 4 |
| 3 | Suitability of Electronic Student Worksheets with Assessment for learning approach | 5 |
| 4 | The correctness of the substance of the learning material | 5 |
| GRAPHICS (CONSTRUCT VALIDITY) | | |
| 1 | Alignment between text, background, image, and table colors. | 4 |
| PRESENTATION (CONSTRUCT VALIDITY) | | |
| 1 | The cover presents the content of the Electronic Student Worksheets | 4 |
| 2 | There is a place to write answers as needed | 5 |
| 3 | Consistency of presentation system | 5 |
| LINGUISTIC (CONSTRUCT VALIDITY) | | |
| 1 | Clarity of information presented | 5 |
| 2 | Conformity with good and correct Indonesian writing rules | 5 |

Construct validity aims to determine the suitability of the substance in the Electronic Students Worksheet with the learning outcomes component. The results obtained from construct validity are the feasibility of the Electronic Students Worksheet graphics with a mode of 4 in the valid category. It indicates that the design in the Electronic Students Worksheet developed is good enough to be used as learning media.

In addition, the results obtained from construct validity are the feasibility of presentation and language. The feasibility of presentation received a mode of 5 in the highly valid category. It shows that the Electronic Students Worksheet developed is consistent in its presentation by being coherent, systematic, and easy to understand as learning media.

The linguistic validity of the Electronic Students Worksheet developed obtained a mode of 5 in the highly valid category. It shows that the Electronic Students Worksheet developed follows the rules of good and correct Indonesian writing, and the information presented is also evident.

**Practicality**

Practicality was obtained from the student's response questionnaire and the students' activity observation sheet as supporting data observed by three observers, namely chemistry students of FMIPA Unesa. The response questionnaire aims to determine students' responses after using the Electronic Student Worksheets oriented assessment for learning to improve their learning outcomes on acid-base titration material. Calculation of the average response of students as follows table 6.

Based on the calculation table data from the response questionnaire results, the Electronic Student Worksheets practicality results were obtained with an overall average of 97.22%, indicating that the Electronic Student Worksheets developed are included in the very practical category. The analysis of student activity observation data also supports this. The following is the calculation of the average student activity.

Table 6. Percentage of The Average Students Response

| No | Statement | ∑ positive response | Percentage |
|---|---|---|---|
| 1. | This Electronic Student worksheet helps me to write down the targets to be achieved in the learning process. | 18 | 100% |
| 2. | Writing the target to be achieved at the beginning of the Electronic Student Worksheets makes me more enthusiastic about achieving the target. | 18 | 100% |
| 3. | This Electronic Student Worksheet does not motivate me to learn acid-base titration material. | 16 | 88.89% |
| 4. | This Electronic Student Worksheet allows me to discuss with educators and peers so that I can understand the material better on acid-base titration material. | 18 | 100% |
| 5. | Discussion activities with peers make me more passive during learning activities in class | 18 | 100% |

| No | Statement | ∑ positive response | Percentage |
|---|---|---|---|
| 6. | Presentation activities in class make me more active during learning activities in class | 17 | 94.44% |
| 7. | The educator's feedback makes me better understand the learning material. | 18 | 100% |
| 8. | Based on the steps in the Electronic Student Worksheets it helps me to know the weaknesses and strengths of the learning method that I use. | 16 | 88.89% |
| 9. | Knowing the weaknesses and strengths of the way of learning that has been used so far makes me recognize a more suitable form of learning in the future. | 18 | 100% |
| 10. | Writing the lesson plan on the Electronic Student Worksheets, my learning is more focused and improves my learning ability. | 18 | 100% |
| | Total | 175 | 97.22% |

Table 7. Percentage of Observations of Student Activities

| No | Meeting | Percentage of Student Activity (%) | |
|---|---|---|---|
| | | Relevant | Irrelevant |
| 1 | 1st meeting: Electronic Student Worksheet Trial of Weak Acid-Strong Base Titration | 93.33 | 6.67 |
| 2 | 2nd meeting: Electronic Student Worksheet Trial of Strong Acid-Weak Base Titration | 96.67 | 3.33 |

Table 8. Percentage of Observation of Student Activities in Each Aspect

| No | Indicator | Percentage of Student Activity | |
|---|---|---|---|
| | | 1st meeting (%) | 2nd meeting (%) |
| 1 | Students write down the target they want to achieve | 6.67 | 6.67 |
| 2 | Students read the phenomenon contained in the Electronic Student Worksheet | 6.67 | 6.67 |
| 3 | Students conduct a titration experiment | 23.33 | 23.33 |
| 4 | Students fill in the data table of experimental results in the Electronic Student Worksheet. | 6.67 | 6.67 |
| 5 | Students analyze the observation data contained in the Electronic Student Worksheet. | 20 | 20 |
| 6 | Students write the conclusion on the Electronic Student Worksheet. | 3.33 | 3.33 |
| 7 | Students present answers to data analysis of experiment results | 10 | 10 |
| 8 | Student answer questions on the Electronic Student Worksheet | 6.67 | 6.67 |
| 9 | Students write a reflection on how they learn | 10 | 13.33 |
| 10 | Activities are irrelevant to the learning process. (Indicators: playing handphone, making noise during learning, asking questions but not related to the subject matter) | 6.67 | 3.33 |

Based on the table above, it can be seen that during the limited trial activities using Electronic Student Worksheets oriented assessment for learning, the relevant activities of students were greater, with an average percentage of at the first meeting and the second meeting of 95% which indicates that the response questionnaire filled out by students is following their honest opinions and circumstances and is relevant to the results of the observed activities.

**Effectiveness**

The effectiveness of Electronic Student Worksheets can be seen from the increase in pretest and posttest results for each student. The students' learning test questions are multiple-choice questions totaling 6 with 5 answer options. The cognitive domains researchers use in making questions are C3 (application) and C4 (analysis). In the implementation of product trials, a pretest was conducted before being given treatment by applying the developed Electronic Student Worksheets and posttest two times. Students are declared complete if they have obtained a score of ≥75.

The results of increasing the N-gain value of each student are different. The improvement in learning outcomes is likely successful if the N-gain

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obtained is in the high or medium criteria. The results of the percentage of students' N-gain are in the following figure:

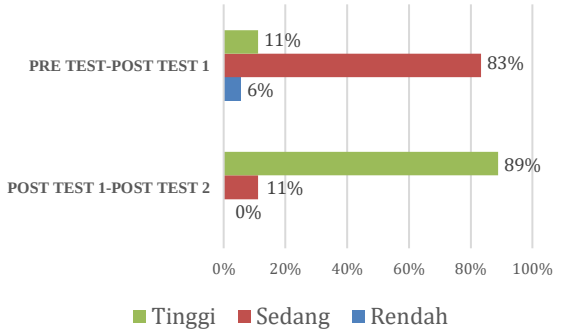


Figure 1. Percentage of N-Gain

Based on the picture above, there are 2 N-gain scores, namely Pretest-Posttest 1 and Posttest 1-Posttest 2. In the Pretest-Posttest 1 N-gain score, 1 student obtained N-gain in the low criteria with a percentage of 6%. In contrast, as many as 15 students obtained N-gain in the medium criteria with a percentage of 83% and as many as 2 students obtained N-gain in the high criteria with a percentage of 11%. Then in the Posttest 1-Posttest 2 N-gain score, there were no students who obtained N-gain in the low criteria so that the percentage was 0%, then as many as 2 students obtained N-gain in the medium criteria with a percentage of 11%, and as many as 16 students obtained N-gain in the high criteria with a percentage of 89%. Students learning outcomes have increased by obtaining an average N-gain pretest-posttest 1 value of 0.53 on medium criteria and an average N-gain posttest 1-posttest 2 value of 0.88 on high criteria. When summed up, The percentage of students in high and medium criteria is 94% at the first meeting. In the second meeting, the percentage of students who were in the high and medium criteria, when summed up, increased to 100%.

## CONCLUSION

Based on the results of research and data analysis, Electronic Student Worksheets can improve students' learning outcomes on acid-base titration material, which is declared feasible in terms of several aspects. Namely, Electronic Student Worksheet is declared valid regarding validation scores with a mode of 5 in the very valid category. It is evidenced by the results of students' responses, with a percentage of students who answered positively by 97.22%, which indicates that the Electronic Student Worksheet developed is included in the very practical category. It is also supported by the results of learner observation activities which show that the relevant activities of students are greater than irrelevant activities, with an average percentage at the first meeting and the second meeting of 95%. Students learning outcomes have increased with the percentage of students in the high and medium criteria when summed up by 94% at the first meeting. In the second meeting, the percentage of students with high and moderate criteria increased to 100%. Based on this, the Electronic Student Worksheet developed is declared effective and can be used as a learning tool to improve student learning outcomes on acid-base titration material.

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